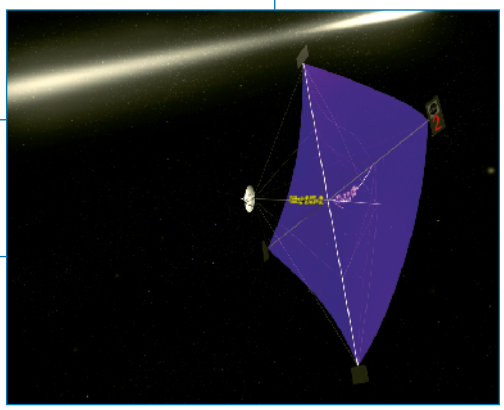
Advanced Space Transportation Technology Summary



Solar Sails

Near the start of the 17th century, German astronomer Johannes Kepler, observing that a comet's tail always faces away from the Sun, concluded that light from the Sun exerts a force that pushes its tail away. This discovery laid the foundation for the concept of "sailing" through space — hoisting thin, reflective sails capable of using sunlight to propel spacecraft the way wind pushes sailboats here on Earth.

Now, NASA researchers are developing solar sail propulsion technologies as a low-cost alternative to chemical rocket propulsion — one that could enable missions, including many that were previously untenable, throughout the solar system.

"Photons," or rays of light emanating from the Sun, could push a solar sail to tremendous speeds — much faster than today's propulsion systems. And because the Sun supplies the necessary propulsive energy, solar sails need no on-board propellant.

The chief advantage of the solar sail is its unique capability to accomplish scientific endeavors in the inner solar system. NASA is now proposing several missions to study the "Sun-Earth Connection," our planet's relationship with its parent star and the turbulent space weather it creates. Because some missions would call for the craft to hover in space, rather than orbit Earth or the Sun, the vehicle would need a constant propulsion source to hold its position. Conventional chemical power or even a very efficient electric propulsion system would require too much fuel to sustain such a mission.

A solar sail, however, could carry out such missions for an extended duration. It would be uniquely suited, for instance, to hover at the so-called "sub-L1 point" in space. The L–1 position is where the gravitational forces of Earth and the Sun are in balance with the force of the sunlight on the sail. A spacecraft at the sub-L1 point could provide early warning of large-scale geomagnetic storms that might threaten satellites in Earth orbit or disrupt and damage communications systems and power grids on the planet.

Sailing in space has only become a real possibility in the last few years, with the advent of strong, lightweight materials. The sail itself could vary in size — depending on the distance to its destination — from the length of the Space Shuttle to that of a football field. The sail would be thinner than cellophane, with a density of just 5-10 grams per square meter. NASA and its partners are now evaluating sail hardware and materials to understand how well they will survive the harsh environment of space.

In summer of 2002, NASA announced the selection of three research organizations to lead key hardware development: L'Garde Inc., of Tustin, Calif., tasked with development of a striped-net sail and inflatable boom model; Able Engineering of Goleta, Calif., tasked with development of an ultra-thin sail and coilable boom model; and NASA's Jet Propulsion Laboratory in Pasadena, Calif., tasked with development of an integrated set of solar sail simulation tools.

Potential near- and mid-term mission candidates for solar sails include:

- The "GeoStorm" Space Weather Sentinel, a proposed series of satellites hovering between Earth and the Sun to study the solar winds, magnetic storms and other natural phenomena;
- The Solar Polar Imager, a proposed mission to place a satellite in a circular, high-incline orbit around the Sun, where sophisticated, on-board imaging instruments could provide unprecedented space weather forecasting; and
- The Particle Acceleration Solar Orbiter, a proposed mission to study the Sun's emissions, especially following coronal eruptions and other large-scale surface disturbances.

Solar sail research is part of NASA's In-Space Propulsion Program, which is managed by the Office of Space Science in Washington, D.C., and implemented by the Marshall Space Flight Center.

For more information about the In-Space Propulsion Program and solar sails research, visit:
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